Solutions Network Formulation Report

Estimating Potential Wind Energy Over the Ocean Using the Aquarius Scatterometer

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1. Candidate Solution Constituents

a. Title: Estimating Potential Wind Energy Over the Ocean Using the Aquarius Scatterometer

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c. Identified Partners: Department of Energy, Energy Efficiency and Renewable Energy branch

d. Decision Support Tool: The Wind Energy Resource Atlas

e. Alignment with National Application: Energy Management

f. NASA Research Results – Table 1:

Missions	Sensors/Models	Data Product
Aquarius	Aquarius Scatterometer	Average wind speeds over the ocean

g. Benefit to Society: Additional renewable energy source through better data in the Wind Energy Resource Atlas

2. Abstract

Use of wind energy has increased significantly over the past decade. However, virtually all wind resources are in remote locations—not close to the power grid or population centers. An alternative to land-based wind farms is to go offshore. NASA's scatterometer data (currently QuikSCAT (Quick Scatterometer) and the future Aquarius) can help identify and quantify potential wind resources over water. The DOE's (Department of Energy's) Energy Efficiency and Renewable Energy branch uses the Wind Energy Resource Atlas as a decision support tool to determine good sites for wind farms, but currently the atlas covers only land areas. NASA scatterometer data over the oceans can be used to update and supplement the Atlas. This candidate solution aligns with the Energy Management National Application.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

Energy is of unquestionable value to industrialized nations. Many traditional sources of energy (e.g., coal and petroleum) are being steadily depleted and cannot be replaced on less than a geological time scale. Other sources of energy (nuclear) have political and social stigmas that make them less than desirable for large-scale applications. Renewable energy sources, such as solar or wind, show promise, but obstacles must still be overcome. One of the fundamental obstacles is locating areas with sufficient wind speed to make the generation of electricity cost effective. Because the energy represented by the wind is proportional to the cube of the wind speed, a single meter per second can have significant impact. Average potential wind energy resources have been mapped over the United States and are recorded in the Wind Energy Resource Atlas of the United States. "This atlas estimates

wind energy resource for the United States and its territories, and indicates general areas where a high wind resource may exist. This information is valuable to wind energy developers and potential wind energy users because it allows them to choose a general area of estimated high wind resource for more detailed examination" (Elliott et al., 1986). The DOE began updating the Atlas in 2000, and in most cases, the updated information includes coastal waters out to approximately 50–100 kilometers (DOE, 2005a). The European Wind Energy Association has documented efforts to exploit wind power in coastal areas with less than 30-meter water depths. "By the end of 2004, a total of almost 605 MW of offshore wind farms had been constructed around Europe in the coastal waters of Denmark, Sweden the Netherlands and the UK." (EWEA, 2005). However, some U.S. coastal regions (e.g., Hawaii) and open ocean are not catalogued the current update of the Wind Atlas. This candidate solution would augment the Wind Energy Resource Atlas to include more areas of potential offshore wind power, thereby identifying possible locations for wind energy farms that may be able to supplement the U.S. energy resources.

b. Identified Partner(s)

The Energy Efficiency and Renewable Energy branch of the DOE has several programs to explore and exploit renewable energy. Its efforts in wind energy are conducted under the Wind and Hydropower Technologies Program. Through this program, the DOE "is working with wind industry partners to develop clean, domestic, innovative wind energy technologies that can compete with conventional fuel sources" (DOE, 2006). The decision-making process for the use of offshore wind resources in deep water (greater than 30 meters) is very complicated with many variables. The location of suitable wind has to be considered along with several other physical factors; e.g., waves, ship and ice interaction, tidal and storm surge depth variation, buoyancy, turbulent winds, icing, currents and tides, marine growth on the submarine portion of the turbine, ease of maintenance, power grid accessibility, population density in the area, etc. (DOE, 2005b).

c. NASA Earth-science Research Results

Aquarius is scheduled to launch in 2009 with a planned 3-year lifetime. The Aquarius mission is designed predominantly for ocean surface salinity measurements using three L-Band radiometers; however, an onboard scatterometer can also be used to derive ocean surface winds. Collecting wind data over the oceans using scatterometers has been common practice for several years. Legacy systems include SeaSat-A (1978), ERS-1 & -2 (1991–current), NASA Scatterometer (1996-1997), SeaWinds on QuikSCAT (1999–current), and SeaWinds on ADEOS II (2003). QuikSCAT data may be used to simulate projected Aquarius scatterometer data. Table 2 shows a quick comparison of data characteristics from these two sensors.

Table 2. Comparison of select specifications of the QuikSCAT and Aquarius scatterometers.

Specification	QuikSCAT	Aquarius
Swath Width	1800 km	373 km
Sample Size	25 km	~90 km
Speed Measurement Window	3-20 m/s	Unknown
Speed Measurement Accuracy	2 m/s	Unknown
Ground Track Repeat	2/day	7 days

d. Proposed Configuration's Measurements and Models

NASA research results from scatterometers have transitioned to the operational world. Data from scatterometers such as QuikSCAT are used in general circulation models to improve accuracy and timeliness of wind products. Aquarius scatterometer data could conceivably replace SeaWinds data in the future to continue that operational status. However, any circulation models that use real-time scatterometer data will have to be modified to accommodate significantly less data from Aquarius

(see Table 2). No anticipated issues are associated with the mission start or lifetime. The wind data that the DOE and wind industry need to select placement of wind turbine farms will be climatological in nature and will not be an ongoing requirement.

Updating the Wind Energy Resource Atlas to include open ocean areas will depend on the use of past and future satellite-based scatterometer data because surface-based wind measurements over these areas are too sparse both spatially and temporally. Accurate wind maps require a climatological approach (decades of data) to capture statistically significant trends, averages, anomalies, etc.

4. Programmatic and Societal Benefits

This candidate solution aligns with the Energy Management National Application by providing an improvement to the tool used to determine offshore areas that have suitable wind speed for energy production. The United States is in need of additional renewable energy sources and the DOE is committed to exploiting wind power—offshore wind power (DOE, 2006). The societal benefit is obvious in reducing the United States' dependence on foreign (or domestic) oil and in enhancing the use of a renewable energy source.

5. References

DOE [Department of Energy], 2005a. *Wind Energy Resource Potential.* Wind & Hydropower Technologies Program, Energy Efficiency and Renewable Energy, http://www1.eere.energy.gov/windandhydro/wind_potential.html (accessed January 17, 2007).

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Elliott, D.L., C.G. Holladay, W.R. Barchet, H.P. Foote, and W.F. Sandusky, 1986. *Wind Energy Resource Atlas of the United States.*DOE/CH10093-4, Solar Technology Information Program, Solar Energy Research Institute, Pacific Northwest Laboratory, http://rredc.nrel.gov/wind/pubs/atlas/ (accessed January 17, 2007).

EWEA [European Wind Energy Association], 2005. *Policy: Offshore*, http://www.ewea.org/index.php?id=203 (accessed January 31, 2007)